afcet

Association Française
pour la Cybernétique Économique et Technique

Avec le soutien de/*With the support of* Université de Lausanne, HEC-INFORGE
(Institut d'Informatique et Organisation)

inforge

CONGRÈS EUROPÉEN DE SYSTÉMIQUE

EUROPEAN CONGRESS ON SYSTEM SCIENCE

CES 1

TOME II

Premier Congrès patronné par
l'Union Européenne de Systémique

LAUSANNE (Suisse/*Switzerland*)
Oct. 3-6, 1989

RELATIONS BETWEEN ECOLOGICAL THOUGHT & SYSTEM THOUGHT

A.J.Hernández* & J.Pastor**

* Ecología. Universidad de Alcalá de Henares, Madrid. España

** U.E.I. Biología Ambiental. Instituto de Edafología y Biología Vegetal. CSIC, Madrid. España.

SUMMARY

This paper shows some of the results we obtained in the course of an investigative project directed toward obtaining guidelines for developing "Ecological Thought" with System methodology in for teaching and learning specific systems.

There is a high level of similarity, between the concept of "Ecological Thought" and "System Thought". Nevertheless, the first term implies a process of developing the human capacity to think totally in line with the new world view and reality, while the second term is mostly a tool for the scientific investigation of all the models of that complex reality that are the General Systems.

RESUME

Ce travail montre quelques résultats obtenus pendant la réalisation d'un project d'investigation orienté vers l'obtention des guides pour le développment de la "pensée écologique" au travers d'une méthodologie systémique pour l'enseignement-apprentissage des systèmes concrètes.

Les résultats obtenus semblent démontrer un grand niveau de coincidence entre les concepts de "pensée écologique" et "pensée systémique". Tandis que la première expresion implique surtout un procès de développment de la capacité humaine de penser avec la nouvelle vision du monde et de la réalité, la deuxième est principalement un outil de l'investigation scientifique pour tous les modèles de la complexe réalité que les systèmes généraux sont.

RELATIONS BETWEEN ECOLOGICAL THOUGHT & SYSTEM THOUGHT

A.J.Hernández* & J.Pastor**

* Ecología. Universidad de Alcalá de Henares, Madrid. España

** U.E.I. Biología Ambiental. Instituto de Edafología y Biología Vegetal. CSIC, Madrid. España.

INTRODUCTION

Our environment is populated by complex beings formed by interacting parts. The classic analytic method first established to explore reality avoided the inherent difficulties in studying interaction (Ashby 1981). Today we know that Science is possible and dynamic because the Universe is a system with a convergent behaviour that allows us to extrapolate from our interpretation of its local interactions (Margalef 1985). There is no doubt that because of the nature of its own object of study, the ecosystem, Ecology has been one of the first sciences to call for a systemic approach to knowledge. At the same time, the discipline of Ecology forces us to modify our old way of thinking (Rosnay 1977).

It has been said that one of the objectives of General Systems Theory is fomenting knowledge transfer between sciences. The first objective of this paper is to approach other scientific disciplines from Ecology by means of an ecological viewpoint. Although each of the terms -methodology, systems, thought or thinking, and ecology- that we use are so complex as to make an attempt at their complete difinition misguided, we hope our brief exposition will give a global view of their nexuses.

The second objective is to give an early report of the general results of the wide-ranging investigative project we (Hernández & Pastor, 1986) began some years ago which is directed towards obtaining guidelines for the development "Ecological Thought" using systemic methodology for teaching - learning specific systems.

THEORETICAL FRAMEWORK

SIMILARITY BETWEEN "ECOLOGICAL THOUGHT" & "SYSTEM THOUGHT"

Our image of the world, or the paradigm within which our civilization functions is complicated. Nevertheless, it seems to have been demonstrated that the cosmology and aboriginal structures of a people, together with the ritual behaviour they generate, fuse with ecological principles (Rogers, 1984; Capra, 1984). Capra noted that the (holistic and ecological) world view of modern Physics emphasizes the fundamental interrelation and interdependence of all phenomena (biological, psychological, social and environmental) and the intrinsically dynamic nature of physical reality. Some authors have spoken of an "ecological paradigm" that would frame this new conception of our perception of the world and of reality. According to Paniker (1984), "Ecology is an epistemologic revolution, that is to say, another way of thinking. It is another logic, not the classic, causal logic; Ecological logic can also be called cybernetic logic". Morin (1983 & 1985) has expressed what is basically the same idea in what he calls an "eco-auto-organizational paradigm" or "complexity paradigm".

Without doubt the key problem is how to approach and explore complexity. Different authors have admitted that complexity has been considered as marginal in epistemology and science as in philosophy, although it appears at the dividing line between engineering and Science in General Systems Theory and Cybernetics. Although aspiring to multidimensionality, the central core of complexity always contains some incomplete or uncertain element. Although complex thought integrates the thought-simplifying processes, and they are disjunctive and analytic, it does attempt to establish an improved and less-mutilating dialogue with reality.

Morin (1985) shows that the level at which complexity can be located depends on the interest level. If one is interested in objects, one can analyse them, take them apart, and they, or the world, seem very simple. If I interest myself in phenomena, there is no doubt that the world is more complicated

everything is interaction, inter-retroaction and interrelation. This means, that according to this author, the concepts of order, disorder, interactions and organization may be complementary. Or, what is to say the same, a phenomenon cannot be reduced to only one of these four concepts, so to understand it, these four concepts should be allowed to interact in accordance with the variations observed in the phenomena themselves. The scientific progress of the last forty years, so influenced by Ecology and the General Systems Theory, is being used to construct a new vision - a ""metamorphosis of man's way of thinking" (Prigogine 1983). We have attempted to come close to this ideal with our study of what we call "Ecological Thought" (Hernández & Pastor 1988). With this term we mean an integrated view of knowledge. Our objective has not only been its theoretical expression, we hope to contribute to the creation of guidelines that help young people to think in an interrelated way so they can advance from an analytic reality to a more integrated one.

Many authors have distinguished two types of thought. They characterize one as analytic, deductive, rigorous, convergent, formal and critical, and the other as synthetic, inductive, expansive, divergent, informal and creative. The efforts to teach "Ecological Thought" must take into account the two types of thought and the so-called "Systemic Thought" attempts to adopt system analysis from reductionism and the synthesis from holism. Both focusses make strange partners, and together they make up the essence of "System Thought" (Aracil, 1986; Hernández 1988). Specifically, "System Thought" is process thought; form is associated with process, interelation with interaction. To say it another way, the practical application of new paradigms to complex systems requires a different logic than the Cartesian one, and it is taking us ever closer to a new interactive interdisciplinarity, because we are reaching the same concepts from different scientific disciplines (Danzin, 1985).

With these considerations we could conclude this section saying that we believe we have found a high degree of harmony between the expressions "Ecologic Thought" and System Thought". However they are not completely coincident. The first term implies more a proc- for

developing the human capacity that is thought, in line with the new reality and world view we have referred to, and the second is better understood as a tool for the scientific investigation of all the models of the complex reality of the general systems.

SIMILARITIES BETWEEN LEARNING AND TEACHING THINKING SKILLS

Of the three possible perspectives for a systemic focus within an educational system as indicated by the UNESCO (1979), we have chosen "learning". Learning englobes the pedagogical concept of the set that defines the teaching-learning strategy. From this starting point, we note the following considerations.

First, theories which explain how people learn are entry-elements for the systemic process, and they are the elements which form the scientific basis of any theory on teaching. However, nowadays the specialists in this subject are transferring their interest from teaching itself to examining teaching-learning. This change is mostly due to the fact that the new theories of learning, greatly inspired by cognitive psychology have spotlighted the active participation of the subject and have centred themselves on how people learn. That is to say, how people manage and transform the new received information and, above all, how they relate it to earlier experiences they have already incorporated. Making learning easier means helping the individual to build his own mental reconstruction of the information to be learned. This change in learning carries along with it a change in our perspective or understanding of the concept of teaching and the teacher's rôle in the teaching process (Beltrán et al. 1987).

Second, most scientists agree that thinking implies codification of the available information on a given situation, some sort of an operation on this encoded information and a derivation of the results that agrees with orienting objectives. Definitively, thought implies codification of the material that is thought and some operation with the codified reconstruction so as to achieve an objective (Nickerson et al. 1987).

The efforts we undertake to improve thought skills would benefit if we could keep these three aspects, encoding, operation and

objective, in mind, and therefore, no curriculum (either at the primary or the university level) that aims to develop an integrated focus of knowledge may simply ignore any one of the three.

At the same time, thought and knowledge are indipendent, as has been explained in the recent papers cited above. It is obvious that the substance of thought, if not the actual process, is limited by what is known, that is by the quantity of accumulated information.

Therefore teaching thinking or thought skills cannot be considered as opposed to teaching the classic curricula, but rather as a complement to this teaching. The capacity for thought and knowledge are like the warp and woof of intellectual competence and the development of either one in detriment of the other results in something that is far from being good quality cloth.

With this in mind, one would suppose a teaching style derived from ecological principles could give wide play to the investigation of the teaching-learning system (Hernández 1987), especially when one remembers that the classroom is not the only interactive system in the learning process.

THE ENVIRONMENT: THE GENERATING NUCLEUS FOR LEARNING ACTIVITIES WITH AN INTEGRATED FOCUS

Over the last decades different authors and schools have been developing ideal methods for environmental investigation of what could, in general terms, be called an integrated focus or systemic methodology. This has allowed us to centre our interest on discovering if this interaction-rich system could also be an object for learning activities that lead individuals to think along the lines of "organized complexity". For several years we have been closing in on this goal from different educational levels (Hernández 1983; Hernández & Gómez, 1983) and from not only the natural environment, but the cultural and social ones as well (Hernández & Pastor, 1988; Gutiérrez et al., 1988).

TABLE 1.- Project Aspects which have been considered the most useful for the interpretation of the environment. (In some cases the respondents have indicated more than one aspect as being helptul and the percentages then and up to more than 100).

ASPECT	85-86	86-87	87-88
Perceptive Dinamics	52	27	42
Application of the Ecologial Method	48	24	38
Thoretical Knowledge of System Methodology	31	50	25

TABLE 2.- The Students Evaluation as to Whether Perceptive Dinamics had improved their perceptive capacity.

GROUP	YES	NO
85-86	98	2
86-87	98	2
87-88	95	5

TABLE 3.- The Students opinion as to how much the combination of Perceptive Dinamics and the Ecological Method increased Their capacity to think in an intergrated manner. Results are given as percentage of answers in each category.

	PERSONAL OPINION			
GROUP	Extremely positive	Very positive	Positive	No help
85-86	87	10	2	1
86-87	78	11	3	5
87-88	73	15	12	0

As they came in, the results lead us to question the idoneity of a combinatory methodology that basically consisted of applying perceptual dynamics at the same time as the ecological method. This was because the learning subjects had difficulty in extracting information from their direct interaction with the environment. This is what underlies our relating a systemic methodology like the one used to study ecosystems, with our interest in contributing to the development of thinking skills that integrate experiences.

The experimental phase of this project is carried out with University students in the last year of their Biology Majors (most are 23 years old) in a natural environment. By perceptual dynamics we mean that perception (which is the first step to scientific knowledge) is based on directly extracting the information contained in an environment by all the participants in the perceptive activities at different moments in time within the ecological system. Learning to perceive not only takes account of conceptual learning but also includes interaction between elements like concepts, stereotypes and values. Ecological method generally consists in extracting information from the system at scales where the environmental factors which are responsible for organizing living beings within an ecosystem operate so that one can study and interpret their organization in an integrated way. This entire phase is supported with the tutorial system so that each individual's learning experiences can be mediated by his tutor.

A total of 206 voluntary subjects have participated in this investigation over the last three academic years (1985–1988) with a yearly mean of 68 students. Tables 1 through 3 show some of the results that confirm our comments. Most of the subjects (over 70%) claimed that the combined methodology helped increase their capacity to "think ecologically". In the many individual interviews we carried out in the course of the tutoring sessions, the students said the course was an initiation to "thinking in a way that was not unconnected", to "learning to ask their own questions", and even to "learning that Science has not got an answer for everything". These kinds of expressions would indicate that approximation to the complexity of a system can, in some way, be estimated with a methodology that is far from being the analytic method.

Another point that we have been able to verify, as have other investigators, is that when people overcome their perceptive limitations in a given environment, the reality they then perceive is surprisingly different from what they had originally imagined. For this reason we say that what can be known is interaction between observer and observed, never just the independent properties of the observed. Logically, interaction implies double flow, in both directions, and we cannot differentiate the value of what is interchanged between the elements of the system (Lahitte, 1987).

Lastly we would wish to emphasize that the results we obtained show that the two forms of interaction between the individual and the environment which best contribute to the development of the individual's cognitive structure are direct exposure to environmental stimuli and the agent (tutor)- mediated learning experiences. Nickerson et al. (1987) also mention similar results in their work.

x Editorial assistance of the I.C.E. at Alcalá de Henares University

REFERENCES

* ARACIL, J. 1986.- Máquinas, sistemas y modelos. Un ensayo sobre Sistémica. Ed. Tecnos, Madrid.

* ASHBY, E. 1981.- Reconciliar al hombre con el ambiente. Ed. Blume. Barcelona.

* BELTRAN, J. et al. 1987.- Psicología de la Educación. Ed. EUDEM. Madrid.

* CAPRA, F. 1984.- El giro decisivo: una nueva visión de la realidad. Ecogiloscopios, Ed. Integral: 39-48.

* DANZIN, A. 1985.- The pervasivenss of complexity: common trends, new paradigms, and research orientations. The Science and Praxis of Complexitg. Ed. The United Nations University: 69-80.

* GUTIERREZ, C.; NOGUERA, C. y HERNANDEZ, A.J. 1988.- Fuera del aula. Cuadernos de Pedagogía, 163: 52-53.

* HERNANDEZ, A.J. 1983.- Experiencias de Eduación Ambiental. Rev. de Juventud, Estudios e Investigaciones. Ed. Ministerio de Cultura, 11: 155-191.

* HERNANDEZ, A.J. 1987.- El paradigma ecológico: marco para la investigación del proceso enseñanza/aprendizaje en ciencias. Enseñanza de las Ciencias, Julio: 50-51.

* HERNANDEZ, A.J. 1988.- El movimiento Sistémico. Crítica, 795: 16-18.

* HERNANDEZ, A.J. y GOMEZ, M.J. 1983.- Hacia una concepción integrada de la naturaleza. Ed. Narcea.

* HERNANDEZ, A.J. y PASTOR, J. 1986.- Hacia la creación de pautas para el desarrollo del pensamiento ecológico. Abstracts I Conference on Human Ecology.

* HERNANDEZ, A.J.and PASTOR, J. 1988.- Searching for Guidelines for "Ecological Thougth" Development. International Journal of Anthropoloy, 3: 145-153.

* LAHITTE, H. 1987.- Relaciones de la Ecología de las ideas a la idea de la Ecología. Ed. Mako. Argenti-

* MARGALEF, R. 1985.- Ecosystems: diversity and connectivity as measurable components of their complication. The Science and Praxis of Complexity. Ed. United Nations Univ.: 228-244.

* MORIN, E. 1983.- El método. la vida de la vida. Ed. Cátedra.

* MORIN, E. 1985.- On the definition of complexity. The Science and Praxis of Complexity. E. United Nations Univ.: 62-68.

* NICKERSON, R.S.; PERKINS, D.N. y SMITH, E.E. 1987. Enseñar a pensar. Ed. Paidos. MEC.

* PANIKER, S. 1984.- Conciencia ecológica. Integral, 62: 10-14

* PRIGOGINE, I. y STENGERS, I. 1983.- La Nueva Alianza. Metamorfosis de la Ciencia Ed. Alianza Universidad.

* ROGER, C.R. 1984.- Un nuevo mundo, una nueva persona. Ecofilosofía. Ed. Integral: 12-21.

* ROSNAY, J. 1977.- El macroscopio. Hacia una visión global. Ed. AC. Madrid.

* UNESCO, 1979.- Enfoque sistémico del proceso educativo. Manual para mejorar la - práctica educativa. Ed. Anaya/UNESCO.